

SECTION 3

SITE CHARACTERIZATION

3.1 INTRODUCTION

3.1.1 Washington State MTCA Chapter 173-340-350 (70(a)) WAC identifies the requirements for a Remedial Investigation (RI), wherein it states “The purpose of the remedial investigation is to collect data necessary to adequately characterize the site for purpose of developing and evaluating cleanup action alternatives. Site characterization may be conducted in one or more phases to focus sampling efforts and increase the efficiency of the remedial investigation.”

3.1.2 The Camp Bonneville RAU 3 site characterization has been conducted in multiple phases of work, with each subsequent phase building upon the findings and conclusions of the prior investigations. The site characterization efforts have included:

- USACE-St. Louis conducted a historical records search and prepared an Archives Search Report in 1997 which details historical findings on Camp Bonneville.
- USAESCH conducted a statistical-based MEC site characterization at Camp Bonneville in 1998.
- USACE Topographic Engineering Center performed a historical aerial photo-analysis of Camp Bonneville in 2000 to identify areas of potential concern (AOPC).
- USAESCH conducted an instrument-aided field reconnaissance to evaluate and document the MEC-related characteristics of the AOPCs in 2001.
- A comprehensive Conceptual Site Model for MEC activities was collaboratively developed by representatives of Washington State Department of Ecology, U.S. EPA Region X, Clark County, and the U.S. Army in 2002.
- USAESCH conducted an additional round of instrument-aided reconnaissance in 2002 to evaluate MEC-related characteristics in the proposed future regional park lands, including the roads and trails, and to confirm/refute the conceptual site model.

3.1.3 The Camp Bonneville RAU 3 site characterization also included the performance of two interim removal actions. These two time critical removal actions (TCRAs) were conducted to address risks associated with the discovery of unexploded

ordnance (UXO) at sites with potential receptor interaction. The following sections discuss the findings of the site characterization studies at Camp Bonneville RAU 3.

3.2 RAU 3 SITE CHARACTERIZATION

3.2.1 1997 USACE Archives Search Report

3.2.1.1 In 1997, the USACE St. Louis District conducted a site inspection, historical records search and interviews of former Camp Bonneville personnel (USACE, 1997). The final archives search report (ASR), dated July 1997, and outlined the nature and degree of potential MEC/UXO contamination at Camp Bonneville. A map showing the locations of reported historical MEC finds on Camp Bonneville is included in the ASR and is shown on [Figure 3.1](#). The ASR concluded that the potential for MEC exists throughout a majority of the installation. The types of items present may range from small arms ammunition to 155mm artillery rounds, up to 4.2-inch mortars, 2.36-inch and 3.5-inch rockets, and hand and rifle grenades. The areas recommended by the ASR for further assessment included the identified ranges and safety fans, mortar positions, artillery firing points, demolition areas, and the central impact area.

3.2.2 1998 USAESCH MEC Site Characterization

3.2.2.1 USAESCH contracted with UXB International Inc. (UXB) to conduct an MEC site characterization of Camp Bonneville in 1998. The purpose of the site characterization study was to determine both the presence and density of MEC at Camp Bonneville. QuantiTech, under contract to USAESCH, used the statistical model SiteStats / GridStats to define the portions of Camp Bonneville to be investigated. SiteStats / GridStats are interactive computer programs that direct UXO sampling and statistically estimate the amount of UXO present at a site based on the UXO sampling data. The UXO sampling results are continually entered into the computer until the programs indicate that sufficient data has been collected to make a statistically valid estimate of the average UXO density in a given area. SiteStats / GridStats have been used for dispersed UXO sites when sufficient site information, usually provided from the ASR, is present to define the sectors.

3.2.2.2 The SiteStats / GridStats basis for sampling is the sequential probability ratio test (SPRT). Implementation of SPRT may result in a reduction in the sample size of up to 50% compared to a fixed-sampling plan approach. For SiteStats, each homogeneous sector is divided into a grid of equal-sized rectangular sampling grids. SiteStats' sector level characterization provides for random (by the software) or user selection of grids for intrusive investigations. Grids are randomly selected and sampled until SiteStats indicates that a sufficient number of grids have been sampled to provide a statistically valid estimate of the average UXO density for the sector. SiteStats also contains mathematical routines that test the hypothesis that the UXO density is sufficiently homogeneous within the sector. If SiteStats determines that the sector is not homogeneous, it will recommend breaking up the sector into smaller sectors. Typical investigation amounts as a percentage of area, assuming sector homogeneity, decrease with increasing sector size. SiteStats is appropriate in cases where prior site activity is understood from historical information.

Figure 3.1 Historical Ordnance Findings

3.2.2.3 GridStats directs sequential sampling within grids. Because some grids contain very large numbers of anomalies, 100% sampling of one of these grids could take weeks to investigate. The application of GridStats to a grid allows the decision-maker to characterize the grid by only investigating a fraction of the total anomalies located within that grid. The idea behind SiteStats / GridStats is to accept a nominal amount of uncertainty in characterizing the individual grids in exchange for a more comprehensive understanding of the MEC distribution of the overall site. The grids are randomly selected for geophysical surveying, and the number of anomalies is identified. The number of anomalies identified is entered into the GridStats program. The anomalies are then selected randomly and excavated to identify the source of the anomaly.

3.2.2.4 QuantiTech, under contract to USAESCH, determined the portion of Camp Bonneville to be surveyed for MEC site characterization purposes using the SiteStats / GridStats statistical sampling model. Camp Bonneville was divided into nine sectors (Figure 3.2). The sectors were selected by reviewing historical range groups from the ASR. A total of 207 geophysical survey grids (each 100-feet by 100-feet) were located throughout the nine sectors. This site characterization sampling strategy created a total survey area of approximately 50 acres. Due to heavy vegetation in some areas, 79 of these 207 grids were “star cut” and surveyed along the cuts. This reduced the total survey area to approximately 40 acres.

3.2.2.5 Visual and geophysical techniques were utilized to locate MEC during the 1998 MEC site characterization study. UXB personnel visually scanned the surface terrain to locate surface MEC or evidence suggesting the presence of subsurface MEC. Geophysical surveys were conducted using the Geonics EM61 High Sensitivity Metal Detector. The EM61 is a time domain metal detector used to detect both ferrous and non-ferrous metals.

3.2.2.6 The software GridStats was used to determine which anomalies were excavated in grids containing more than twenty anomalies. The GridStats guideline indicated that the first 20 anomalies of any grid had to be investigated. If more than twenty anomalies were identified, 32% of the remaining anomalies were excavated. All identified anomalies were investigated on “star cut” grids, regardless of quantity. During UXB’s operation, UXO items were found by one of three means: UXB personnel providing escort to survey teams from grid to grid, UXB personnel providing grid surface sweeps prior to brush clearing, and UXB intrusive actions after EM61-determined anomalies were selected by the geophysicist.

3.2.2.7 UXO items were found in four of the nine sectors during the 1998 site characterization. [Table 3.1](#) summarizes the results of the 1998 MEC site characterization findings. [Figure 3.2](#) shows the location of the grids that were mapped and intrusively investigated for the site characterization.

Figure 3.2 1998 Site Characterization Grid Location Map

TABLE 3.1
SECTOR SUMMARY

Sector Number	Sector Description	Approx. Area (Acres)	Approx. Area Sampled (Acres)	Number of Grids	UXO Items Found in Grids*	Total UXO Items Found**
1	Camp Area	320.91	5.33	26	0	0
2	Demolition Area	392.29	5.28	27	2	2
3	Impact Area A	429.04	6.89	30	1	1
4	Impact Area B	223.96	4.04	20	0	0
5	Impact Area C	648.15	4.41	28	0	0
6	Impact Area D	685.32	4.91	25	4	4
7	Impact Area E	763.65	4.76	30	0	0
8	Impact Area F	398.70	3.72	17	0	0
GR	M203 Grenade Ranges	93.85	.92	4	4	9
TOTAL	All Sectors	3955.87	40.26	207	11	16

* Numbers indicate UXO found in dig sheet summarization and do not indicate UXO found between grids.

** Total includes 5 additional UXO recovered during brush clearance and/or movement between grids.

3.2.2.8 UXB investigated a total of 2,468 anomalies during the 1998 site characterization study. The following materials were found:

- 185 pounds of non-MEC related scrap,
- 213 pounds of munitions debris (i.e., inert scrap remnants of munitions),
- 16 UXO items (Eleven during intrusive activities and five during surface clearance and movement between grids),

3.2.2.9 The MEC sampling results were consistent with the data released in the ASR and are summarized as follows:

- Direct fire weapons (i.e. 2.36" and 3.5" rockets) were found in Sectors 6 and 5.
- Indirect fire munitions (mortar and artillery) were found in Sectors 6, 7, and 8.
- Inert, sand-filled Stokes mortar rounds were found in Sector 3.
- No 40mm HE or Light Anti-tank Weapon (LAW) High Explosive Anti-Tank (HEAT) munitions were encountered, and surveillance of the range targets revealed no surface indication of their presence (i.e. fragmentation marks, singed holes, explosive component debris). However, within the 40mm/LAW ranges in Sector 3, numerous inert 40mm training rounds and inert LAW sub-caliber components were discovered.

- The survey within the demolition range located in Sector 2 (Demo 1) revealed both UXO and MEC scrap. These findings represent “kick-out” from disposal activities. In Sector 3 near grid 116, deep craters and MEC scrap indicate the location of a suspected demolition range (Demo 3).

3.2.3 USAESCH 1998 Time Critical Removal Action

3.2.3.1 USAESCH contracted with UXB to conduct an interim removal action (TCRA) at the conclusion of the 1998 site characterization study. This interim removal action consisted of a surface clearance of 10 acres at the Open Burning / Open Demolition (OB/OD) site located in the northwestern portion of the Camp Bonneville property, at the area known as “Demo 1”. A total of eight (8) UXO items, including two 2.75-inch HEAT rockets and six (6) 35mm LAW subcaliber practice rounds (with spotting charges) were removed during the 10-acre surface clearance at the Demo 1 area. [Figure 3.3](#) shows the location of the TCRA grids at Demo 1.

3.2.4 USAESCH 1999 Time Critical Removal Action

3.2.4.1 USAESCH contracted with UXB to conduct a second interim removal action (TCRA) at Camp Bonneville in 1999. The TCRA required the removal of all live and inert MEC to a depth of two feet in the two former M203 rifle grenade ranges. The two former ranges were located in the central portion of the site adjacent to Lacamas Creek ([Figure 3.4](#)). USAESCH required the contractor (UXB) to geophysically map the areas after the removal operation was concluded for quality assurance purposes.

3.2.4.2 The original area of clearance was expanded from 12 acres to 19 acres. This 7-acre buffer addition was included to cover additional acreage suspected of MEC contamination at the ranges. One hundred percent of the cleared area passed UXB’s quality control and USAESCH’s quality assurance inspections. Upon discovery of an MEC item that could not be positively identified as inert, the item was treated as UXO for safety purposes. Subsequently, the item in question would be explosively destroyed where it was found. The final UXO determination was made by observations of the final demolition. If there was no contribution to the initial demolition charge, the item was identified as munitions debris (MD). [Table 3.2](#) lists the items and locations of suspect items that were shown to be MD through explosive demolition.

3.2.4.3 A total of three (3) UXO items were discovered during the removal action at the two former M203 rifle grenade ranges. These three 40mm M382 practice projectiles added a noticeable contribution to the donor charge at the time of demolition and were found at the M203 Practice Range. Based on this observation, the items were classified as UXO items. [Table 3.3](#) lists the projectiles and their locations.

3.2.4.4 UXB located over 3,800 pounds of inert MD and 684 pounds of non-MEC related scrap during the 1999 TCRA. When the scrap was located, it was inspected and certified as free of explosives. [Table 3.4](#) lists the quantity of Inert MD located during their 1999 removal action at the two former M203 rifle grenade ranges.

Figure 3.3 Demolition Area 1 Interim Removal Action

Figure 3.4 M203 Ranges Interim Removal Action

**TABLE 3.2
SUSPECT MUNITIONS DEBRIS**

Item	Quantity	Location
Rocket, 35mm, Practice, Sub-caliber, M73	1	Sector 3, Grid 1
Rocket, 35mm, Practice, Sub-caliber, M73	1	Sector 3, Grid 4
Rocket, 35mm, Practice, Sub-caliber, M73	1	GR, Grid 2
Rocket, 35mm, Practice, Sub-caliber, M73	2	GR, Grid 3
Rocket, 35mm, Practice, Sub-caliber, M73	1	GR, Grid 5

Note: All six suspect munitions debris recovered from a range of 4 to 9-inches below ground surface.

**TABLE 3.3
UXO ITEMS**

Item	Quantity	Location
Projectile, 40mm, Practice, M382	1	Sector 3, Grid 12
Projectile, 40mm, Practice, M382	1	Sector 3, Grid 13
Projectile, 40mm, Practice, M382	1	Sector 3, Grid 16

Note: All three UXO items recovered from a depth less than two inches below ground surface.

**TABLE 3.4
INERT MUNITIONS DEBRIS**

Item	Quantity	Status	Depth Range
40mm Practice Grenade	6,666	Inert	0 to 9 inches
Cartridge Case (Brass)	21,730	Inert	0 to 6 inches
Sub-caliber	3,003	Inert	0 to 14 inches
Grenade Fuze	145	Inert	0 to 3 inches
3" Stokes Mortar	43	Inert	0 to 6 inches
MK II Practice Grenade	2	Inert	0 to 2 inches
Slap Flare	52	Inert	0 to 2 inches
M583 White Star Flare	1	Inert	0 to 2 inches
M661 Green Star Flare	2	Inert	0 to 2 inches
81mm Mortar, Practice, M68	11	Inert	2 to 6 inches
MK 2 Impulse Cart	1	Inert	0 to 1 inch
Smoke Grenades	9	Inert	0

3.2.5 USACE 2000 Aerial Photograph Examination

3.2.5.1 The USACE Topographic Engineering Center (TEC) analyzed available historical aerial photographs for the Camp Bonneville area to identify and map suspect features. Photo-analysis was based upon the interpretation of black and white aerial photography over the project area from 1940 through 1980. Also, historical range maps for the time frame of 1926 through 1991 and digital orthophotos (photomaps) from the time period of 1990 and 1998 were used in order to identify suspect features on the installation. TEC photo-analysis identified approximately 677 features as a result of the aerial photograph analysis. The photo-identified features selected were described as structures, berms, ground scars, depressions, and cleared areas.

3.2.5.2 These features were subsequently characterized as “areas of concern” (AOCs) if the area could be identified as historical training locations, munition practice ranges, demolition areas, impact areas, or munition storage facilities. Alternatively, if TEC-identified areas could not be identified based on Camp Bonneville’s historical records, these areas were characterized as Areas of Potential Concern (AOPCs).

3.2.6 2001 USAESCH Instrument-Aided Field Reconnaissance

3.2.6.1 USAESCH contracted with Parsons to conduct an instrument-aided reconnaissance site characterization study (reconnaissance investigation). The reconnaissance investigation field work was accomplished during November and December of 2001. This site characterization study was conducted to confirm the positional location and characterize the MEC-related characteristics of AOCs/AOPCs at Camp Bonneville.

3.2.6.2 The AOCs and AOPCs investigated during the 2001 field effort were originally identified based on historical aerial photographs by the USACE TEC. Parsons evaluated each of these 677 TEC-identified features from year to year and identified 108 unique features that potentially required further characterization. This process of identification was performed by eliminating repeat areas, areas not considered AOPCs, (i.e. lagoons, ponds, buildings, and roads), and areas recognized as the result of tree harvesting operations. Of the 108 AOC/AOPC identified as unique features, 79 were determined to require reconnaissance (Parsons, 2001). The remaining 29 AOPC sites were not identified for reconnaissance because they were associated with small arms ranges or were co-located with other areas already identified for reconnaissance efforts. The AOC/AOPCs identified for reconnaissance were geo-rectified using ArcView geographic information system (GIS). The geo-rectification resulted in describing the positional location of each of the AOC/AOPC, with the latitude and longitude for each of these features. The geographic location of the AOCs/AOPCs is shown on [Figure 3.5](#).

3.2.6.3 The AOC/AOPCs were characterized for MEC-related and terrain/vegetation/cultural feature characteristics during the 2001 reconnaissance investigation. During the 2001 reconnaissance investigation field effort, the positional location of each AOC/AOPC, as described by the longitude and latitude coordinates of

Figure 3.5 AOC/AOPC Locations

the center or the points identified on the perimeter of the AOC/AOPC, were imported into the GPS units at the beginning of each day. The reconnaissance team navigated to the latitude and longitude of the AOC/AOPC. Upon reaching the desired AOC/AOPC location, the reconnaissance team members formed a line with the spacing specified by the type of weapons system used in the area under investigation. [Table 3.5](#) summarizes the reconnaissance line spacing.

TABLE 3.5
2001 RECONNAISSANCE LINE SPACING

AOC/AOPC	Reconnaissance Spacing (Meters)
Target/Impact Areas	
- 75mm Weapons System	50
- 105mm Weapons System	100
- 2.36"/3.5"/14.5mm Weapons	20
- Individual MEC Items	5
Munition Disposal Areas	5
Troop Training / Maneuver Areas	10
Firing Points	5
Safety Fans	No Reconnaissance Proposed
Ammunition Storage	No Reconnaissance Proposed

3.2.6.4 A 50-foot buffer around each AOC/AOPC was used. The reconnaissance buffer was utilized to compensate for the potential positional error associated with using varied data sources and data analysis processes, including aerial photographic maps, topographic maps, geo-rectification, and GPS. The teams performed a reconnaissance survey at each AOC/AOPC in a linear fashion and conducted additional transects as necessary until each AOC/AOPC had been fully characterized. Reconnaissance data was collected in accordance with the Reconnaissance Standard Operating Procedure (SOP)(Parsons, 2002). The field data was collected on hand-held personal digital assistants (PDAs) using a site-specific collection format created using Pendragon™ software. In addition to recording information regarding possible MEC, information regarding terrain, vegetation, and cultural features was also recorded.

3.2.6.5 The 2001 reconnaissance investigation of 79 AOCs/AOPCs resulted in the collection of 3,195 data points ([Figure 3.6](#)). The reconnaissance team surveyed approximately 700 acres of known/suspect MEC-related source sites. Of the 3,195 points collected, 146 identified the location of military related items. A detailed description of the types of munition related items located is included in Appendix A. The MD scrap and UXO findings of the 2001 reconnaissance field effort are presented in [Table 3.6](#) and [Table 3.7](#), respectively. The location of these items is plotted on [Figure 3.7](#).

Figure 3.6 AOC/AOPC Locations and 2001 Reconnaissance Waypoints

D R A F T

Figure 3.7 OE Scap and UXO Item Locations 2001 Reconnaissance

TABLE 3.6
MUNITIONS DEBRIS FOUND DURING 2001 INVESTIGATION

Item	Quantity
Rocket, 3.5in, Practice, M29 warhead, empty	1
Rocket, 3.5in, Practice, M29 w/M405 Dummy fuze, fired	10
Rocket, 3.5in, motor, expended	1
Rocket, 2.75in, Mk40, Mod7 motor, expended	1
Rocket, 2.36in, Practice, M7, expended	1
Pyrotechnic, Signal, Illumination, M126 series, expended	5
M49 Trip Flare Housing, expended	1

3.2.6.6 A single UXO item was located during the 2001 investigation in the central impact area of Camp Bonneville.

TABLE 3.7
UXO FOUND DURING 2001 INVESTIGATION

Item	Quantity
Projectile, 105mm, HE, M1, fired	1

3.2.7 MEC Conceptual Site Model

3.2.7.1 The MEC Conceptual Site Model (MEC CSM) for Camp Bonneville serves as the overarching framework for organizing all available archival information about MEC-related activities, munition uses, and expected MEC contamination at Camp Bonneville. The CSM was developed through collaborative efforts of Washington State Department of Ecology, Clark County, U.S. EPA, and U.S. Army representatives in March-June 2002. [Table 3.8](#) summarizes the components of the CSM for Camp Bonneville. The components of the MEC CSM include:

- MEC Related Activities;
- MEC Source Types;
- Primary Release Mechanisms;
- Expected MEC Contamination; and
- Likelihood of MEC Contamination.

TABLE 3.8
MEC CONCEPTUAL SITE MODEL COMPONENTS

MEC Related Activity	Primary Source	Likelihood of MEC Contamination
Ordnance Storage	Storage Magazines/ Transfer Point	Low
Weapons Training	Firing Point	Medium
	Target Areas	High
	Range Safety Fan	Low
Troop Training	Training Area	High
	Maneuver Area	Low
Ordnance Demilitarization	Open Burn/Open Detonation Area (OB/OD)	High

3.2.7.2 The MEC CSM described all of the MEC-related activities that historically occurred on Camp Bonneville as one of the following:

- Ordnance Storage – includes the storage and issuance of munitions used on Camp Bonneville.
- Weapons Training – the training of military personnel in the use of weapons systems within fixed, established firing ranges. On Camp Bonneville, weapons training occurred for artillery, mortars, hand grenades, practice land mines, rifle grenades, and rockets.
- Troop Training – the training of military personnel in combat techniques and maneuvers.
- Ordnance Disposal – the disposal of munitions that had undergone incomplete detonation and UXO at fixed, established Open Burn/Open Detonation (OB/OD) areas.

3.2.7.3 Each of the MEC-related activities listed above had one or more MEC Source types associated with it. For Camp Bonneville, seven MEC Source types were identified.

The MEC Source types associated with the listed munition-related activities are:

- Ordnance Storage
 - Storage Magazine/Transfer Point – the buildings in which munitions were stored, and from which it was issued to personnel.
- Weapons Training

- Target Area – a fixed area at which weapons training exercises were targeted; target areas for the larger weapons systems may contain vehicles and old appliances as target items.
- Firing Point – the fixed point from which the weapons were fired during weapons training exercises.
- Range Safety Fan – the buffer area, fanning out from the firing point to beyond the target area, established to ensure weapons training was carried out safely.
- Troop Training
 - Training Area – areas used to train military personnel in offensive and defensive techniques. On Camp Bonneville, this training included the establishment of defensive perimeters (using training or practice munitions, with or without spotting charges), the infiltration of defensive perimeters, the use of small arms with blank ammunition, and the establishment of bivouac areas.
 - Maneuver Area – areas used for small unit (platoon/squad) troop maneuvers, without the intentional deployment of weapons.
- Ordnance Disposal
 - Open Burn/Open Detonation (OB/OD) Area – a fixed area used to dispose of MEC through detonation or burning

3.2.7.4 The mechanisms by which MEC was released into areas on Camp Bonneville fell into two categories, based upon the types of activities and MEC sources associated with the areas. The first release type was described as releases that resulted from intentional activities, such as firing into a target area, the placement of signaling devices (trip flares) during the establishment of a defensive perimeter, or the disposal of MEC by detonation in an OB/OD area. The second category of MEC release types are releases that were incidental to the MEC-related activities, such as a long- or short-round fired rounds into a range safety fan, the loss of hand grenades during troop maneuvers, or the burial of excess rounds at an isolated firing point. The third column of Table 3.9 shows the release mechanisms associated with each MEC Source type.

3.2.7.5 The Camp Bonneville MEC CSM addressed the expected MEC contamination that may result in an explosive hazard. Contamination that may result in an explosive hazard includes UXO and buried munitions that were not deployed. The fourth column of [Table 3.9](#) shows the expected contamination associated with each MEC Source type and MEC release mechanism, while the fifth column shows the anticipated likelihood of MEC contamination for each MEC Source type. Potential contamination from explosive residuals, including the potential for release of explosives into the soil through low-ordered detonations and the corrosion of the cases of buried munitions is not addressed in this RAU 3 RI/FS Report.

TABLE 3.9
MEC RELEASE MECHANISMS

MEC Related Activity	MEC Source	Primary Release Mechanism	Expected MEC Contamination	Likelihood of MEC Contamination
Ordnance Storage	Storage Magazines/ Transfer Point	Mishandling/Loss	Non-deployed munitions	Low
Weapons Training	Firing Point	Mishandling, Loss or Abandonment	Non-deployed munitions	Medium
		Burial	Non-deployed munitions	Medium
	Target Areas	Firing – Incomplete Detonation	Deployed Munitions that failed to function as designed	High
		Firing – UXO	Deployed Munitions that failed to function as designed	High
		Firing – Complete Detonation	Non-explosive debris	High
	Range Safety Fans	Firing – Incomplete Detonation	Deployed Munitions that failed to function as designed	Low
		Firing – UXO	Deployed Munitions that failed to function as designed	Low
		Firing – Complete Detonation	Inert MD / Non-explosive debris	Low
Troop Training	Training Area	Mishandling or Loss	Non-deployed (fuzed or unfuzed) training/practice munitions	High
		Burial (Bivouac Areas only)	Non-deployed (fuzed or unfuzed) training/practice munitions	High
		Placement	Emplaced Training Munitions (fuzed or unfuzed)	High
	Maneuver Area	Mishandling or Loss	Non-deployed (fuzed or unfuzed) training / practice munitions	Low
Ordnance Demilitarization	Open Burn/Open Detonation (OB/OD)	Kick-Out/ Incomplete Detonation (OD)	Deployed/Non-deployed munitions that have undergone unsuccessful demilitarization	High
		Complete Detonation	Inert MD / Non-explosive debris	High
		Burning	Deployed or Non-deployed munitions that have undergone unsuccessful demilitarization	High

3.2.7.6 The CSM ranking factors address the explosive safety hazards resulting from the release of explosives. Two factors were used to develop the explosive hazard ranking for the seven primary source types. The first factor was the likelihood of MEC contamination, and the second factor was the explosive hazard severity.

3.2.7.7 The likelihood of MEC contamination was a qualitative ranking of the relative likelihood that MEC/UXO contamination was present at an AOC/AOPC. The default values for this factor were based on the MEC Source types. MEC Source types that were the subject of intentional releases of munitions (e.g., target areas) were assigned a high likelihood of MEC contamination. MEC Source types where the release of MEC was unintentional (e.g., maneuver areas) were assigned a low likelihood of MEC contamination. A medium likelihood of MEC contamination was assigned to the Firing Point primary source type. The CSM for Firing Points hypothesized a potential for the intentional abandonment or burial of unfired munitions. This scenario was a case where the release was the result of intentional activity, but the activity was not sanctioned.

3.2.7.8 Table 3.9 summarizes the components of the CSM for Camp Bonneville. The appropriate MEC Source type for each AOC/AOPC was obvious for most areas. Since all of Camp Bonneville was designated for troop training, in the absence of other information about an area, an area was assigned the Maneuver Area MEC Source type.

3.2.7.9 The MEC anticipated to be located at the Camp Bonneville MEC Sources was characterized by the likelihood of detonation and the resultant explosive safety hazard. [Table 3.10](#) provides the Hazard Severity Ranking (HSR) and Explosive Safety Hazard (ESH), with items categorized as 1 having the highest explosive safety hazard and 5 having the lowest explosive safety hazard.

TABLE 3.10
HAZARD SEVERITY RANKING (HSR) AND EXPLOSIVE SAFETY HAZARD (ESH)

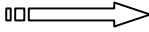
Hazard Severity Ranking (HSR)	Title	Explosive Safety Hazard	Description
1	UXO with sensitive fuzing	Catastrophic	Deployed munitions; e.g.: fired munitions with sensitive fuzing that have failed to function as designed
2	UXO	Critical	Deployed munitions; e.g.: fired munitions with less sensitive fuzing than HSR 1, that have failed to function as designed and/or have undergone unsuccessful demilitarization (detonation)
3	Military Munitions damaged during handling	Marginal	Non-deployed munitions; e.g.: never been fired munitions that have undergone unsuccessful demilitarization (detonation) that may have stressed the fuze; emplaced training munitions (trip flares, booby traps) in which the fuzing is armed
4	Military Munitions, Training Munitions	Negligible	Non-deployed munitions; e.g., buried/ abandoned munitions; emplaced training munitions (trip flares, booby traps) whose fuzing is not armed; bulk explosives or explosive soil; complete, ready-to-fire small arms ammunition. Deployed munitions; e.g.: practice and training munitions with spotting charges
5	Munitions Residue	Non-explosive	Non-explosive debris; e.g.: munition fragments; training munitions with no spotting charges; and explosive residue (3X AEDA material with no visible ordnance contamination)

3.2.7.10 The Camp Bonneville MEC CSM is a comprehensive evaluation of past MEC activities at the Camp Bonneville site. Each MEC-related activity performed at Camp Bonneville has been identified through a rigorous and methodical evaluation of

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archival information and the activities conducted during military troop training for artillery and infantry missions. In addition, each MEC Source type, expected MEC release method(s) and expected MEC contamination has been identified and fully evaluated for explosive safety risk factors. [Table 3.1](#) shows the compilation of the MEC CSM for Camp Bonneville, and includes a relative ranking of explosive safety risk by MEC Source type.

TABLE 3.11
EXPLOSIVE SAFETY RELATIVE RISK RANKING FOR CAMP BONNEVILLE, WA

MEC Related Activity	Primary MEC Source	Non-deployed munitions (4)	Practice munitions without spotting charge (4)	Practice munitions with spotting charge (4)	Unsuccessfully demilitarized non-deployed ordnance (3)	Unsuccessfully demilitarized deployed ordnance (2)	Deployed munitions that failed to function as designed (2/1)	Munition Fillers	Likelihood of MEC Contamination	Explosive Safety Relative Risk Ranking
Ordnance Storage	Storage Magazines/ Transfer Points	X						E, P	Low	6
Weapons Training	Firing Point	X						E, P	Medium	3
	Target Area						X	E, P	High	1
	Range Safety Fan						X	E, P	Low	5
Troop Training	Training Area		X	X				P	High	4
	Maneuver Area	X						P	Low	7
Ordnance Demilitarization	Open Burn/Open Detonation Area				X	X		E, P	High	2
		Least Severe					Most Severe	Munition Filler: E =Explosive P = Pyrotechnic		Highest Explosive Safety Relative Risk Ranking is 1 and Lowest is 7

3.2.8 2002 USAESCH Instrument-Aided Field Reconnaissance

3.2.8.1 USAESCH contracted with Parsons to conduct a supplementary round of site characterization using instrument-aided reconnaissance (reconnaissance investigation). The reconnaissance investigation field work was accomplished during December 2002 through February 2003.

3.2.8.2 The area covered by the 2002 reconnaissance investigation included the approximate 1,200 acres of the proposed future regional park and the existing trails and roadways that cross Camp Bonneville. The investigation resulted in the collection of 12,809 reconnaissance data waypoints. The proposed Regional Park (RP) area was divided into fifteen (15) discrete sections for data management purposes. The section boundaries generally corresponded to a physical feature, such as a creek bed, fence-line, or roadway. These subdivided areas were labeled “RP- X”, with X being a numeral between 1 and 15 ([Figure 3.8](#)). An additional RP area (designated RP-16) was subsequently identified by USAESCH for reconnaissance investigation. This RP-16 area

Figure 3.8 Regional Park Section Boundaries 2002 Reconnaissance

is described to encompass the area between Demo 1 and the confluence of the north and south forks of Lacamas Creek and is also shown on Figure 3.8.

3.2.8.3 The RP areas were characterized for potential MEC-related activities, as well as terrain, vegetation, and cultural features. The RP areas were surveyed individually by the field reconnaissance teams. The reconnaissance team would navigate to the RP area to be surveyed and would then form a line with a distance between individuals of 10-15 meters as specified by the Final Reconnaissance Work Plan (Parsons, 2001b). The team members proceeded along the reconnaissance transects, collecting data in the PDA Pendragon™ format discussed in section 3.2.6.

3.2.8.4 When the RPs were completed, the teams surveyed the existing roads and trails across the Camp Bonneville site. The procedure for road and trail coverage was for a team member to survey the center of the road while the remaining team members were located approximately 30 feet on either side of the road. This technique was used to establish a buffer around the roads and trails. While surveying the previously mapped roads and trails, the reconnaissance discovered a number of previously unknown roads or trails. These newly discovered roads and trails were also characterized to obtain information on potential MEC-related activities, terrain, and vegetation along the roads and trails.

3.2.8.5 The roadways and trails throughout the entire Camp Bonneville facility, as shown on [Figure 3.9](#). No UXO items surveyed were located during the 2002 reconnaissance investigation of the proposed regional park lands or along the roads and trails across the Camp Bonneville site.

3.2.8.6 A total of 315 of the 12,809 waypoints obtained were military-related features. Of these 315 military-related features, a total of 38 were inert MD items. Training-related items located during the 2002 reconnaissance investigation were classified as either MEC scrap (i.e., expended slap flares and expended smoke grenades) or training-related scrap (i.e., meal-ready-to-eat (MRE) bags and small arms cartridges). Identified areas that were previously used for military training were identified as training features (i.e.: obstacle course and small arms ranges). The MD scrap items located during the 2002-2003 reconnaissance field effort are presented in [Table 3.12](#) and the location of these items is plotted on [Figure 3.10](#).

3.2.8.7 The 2002 reconnaissance investigation characterized the location and distribution of MEC-related items and features on the 1,200 acres of the proposed future regional park lands and along approximately 46 miles of trails and roads across the entire Camp Bonneville site. A total of 12,809 data waypoints were collected and recorded. Not a single UXO item was discovered in the 1,200 acres surveyed by the 2002 reconnaissance efforts. A total of 38 inert MEC scrap items were located, including expended trip flares, expended slap flares, expended smoke grenades, and expended, inert practice 40mm projectiles and expended practice 2.36-inch rocket body. None of the MEC-related items located within the proposed future regional park or along the roads and trails during the 2002 reconnaissance poses an explosive safety risk.

Figure 3.9 Road and Trail Waypoints 2002 Reconnaissance

D R A F T

Figure 3.10 OE Scrap Item Locations 2002 Reconnaissance

TABLE 3.12
MD FOUND DURING THE 2002-2003 RECONNAISSANCE

Item	Quantity
Grenade, Hand, Smoke (HC), AN-M8 w/M201A1 fuze, expended	1
Grenade, Hand, Smoke, M18 series w/M201A1 fuze, expended	6
Projectile, 40mm, Practice, M781, fired, expended, nose cap	8
Projectile, 40mm, Signal-Illumination, M661, expended	1
M49 Trip Flare Housing, expended	2
Pyrotechnic, Signal, Illumination, M126 series, expended	14
Pyrotechnic, Simulator, Illumination, Parachute, M583A1, expended	1
Pyrotechnic, Simulator, M117 series, expended	2
Pyrotechnic, Simulator-artillery, M74A1, expended	1
Pyrotechnic, Simulator-Ground Burst, M115A2, expended	1
Rocket, 2.36in, Practice, M7, expended	1

3.3 RAU 3 SITE CHARACTERIZATION SUMMARY

3.3.1 Camp Bonneville has been thoroughly characterized for the presence, location, and density of MEC that are artifacts of past troop training activities conducted during the period of active use (1910 – 1995) for the installation. The Camp Bonneville RAU 3 site characterization has been conducted in multiple phases of work, with each subsequent phase building upon the findings of the prior investigation findings.

3.3.2 A total of 207 MEC sampling grids, totaling approximately 40 acres, were geophysically mapped and intrusively sampled. A total of sixteen (16) UXO items were recovered during this phase of site characterization. All of these UXO items were recovered from the Central Impact Target Area, the M203 Grenade Range, and the Demolition Areas 1 and 3. As a result of these site characterization findings, an additional 29 acres of land was cleared of MEC during the implementation of interim removal actions. The initial interim removal action (TCRA) was performed at Demolition Area 1 and recovered a total of eight (8) UXO items from 10 acres of surface clearance. The second interim removal action (TCRA) was performed at the M203 Grenade Ranges in 1999 and recovered a total of three (3) UXO items from 19 acres. [Figure 3.11](#) shows the locations of UXO items located during the Camp Bonneville site characterization. A detailed description of UXO and MEC scrap items located is included in Appendix A.

3.3.3 A total of 16,004 discrete reconnaissance data waypoints have been collected, analyzed, and mapped using digital technology and GIS geo-spatial analysis during the 2001/2002 site reconnaissance efforts. Over 2,400 acres of the 3,980 acre site has been characterized for the presence of potential MEC-related activities. A solitary UXO item (105mm artillery shell) was located in the Central Impact Target Area. A total of

Figure 3.11 UXO Site Characterization Findings